

# Experiments Beyond the Tonne-Scale: Background Challenges



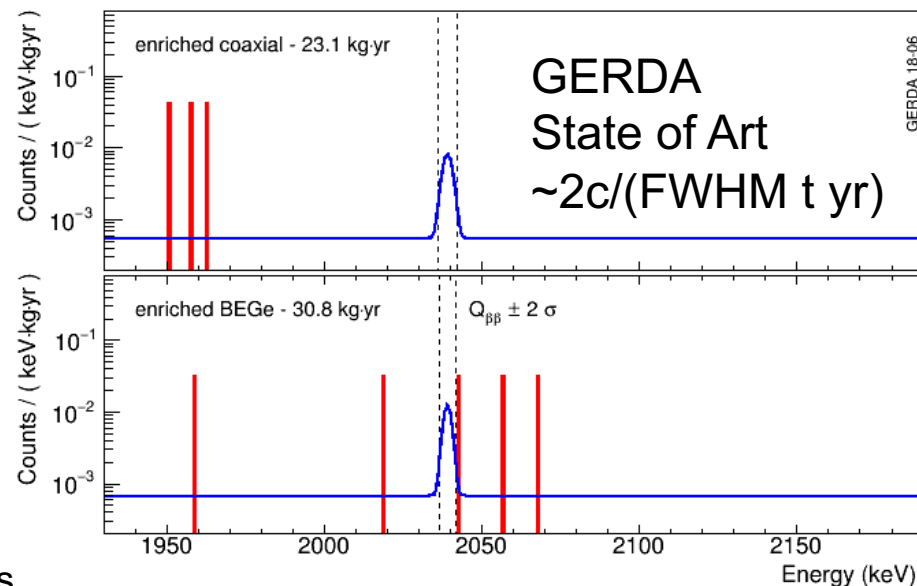
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# Background Considerations

## “the Usual Suspects” but also some new players

- Natural occurring radioactive materials in detector apparatus
  - U/Th/K in detector materials or from contamination, radon daughter plate-out
- Environmental  $\gamma$ s
  - The lab environment, radon
- Prompt  $\mu$
- $2\nu\beta\beta$ 
  - need energy resolution
- Long-lived cosmogenics
  - Exposure on Earth’s surface
- Anthropomorphic activities
  - Fallout
- Neutrons from  $(\alpha,n)$ , fission, or  $\mu$  interactions
  - in situ produced activation products,  $(n,n')$  emissions
- Solar Neutrino Interactions

Always an issue  
Mostly solved  
Upcoming concerns



# The usual suspects

- Natural Occurring Radioactive Materials

- Solution mostly understood, but hard to implement

- Great progress has been made understanding materials and the U/Th contamination, purification
- Elaborate QA/QC requirements

- Future purity levels greatly challenge assay capabilities

- Some materials require levels of 1  $\mu\text{Bq/kg}$  or less
- Sensitivity improvements required for ICPMS,  $\gamma$  counting, NAA
- Assay techniques have equilibrium assumptions
- Sample testing doesn't always reflect installed materials

- Prompt  $\mu$  and environmental  $\gamma$

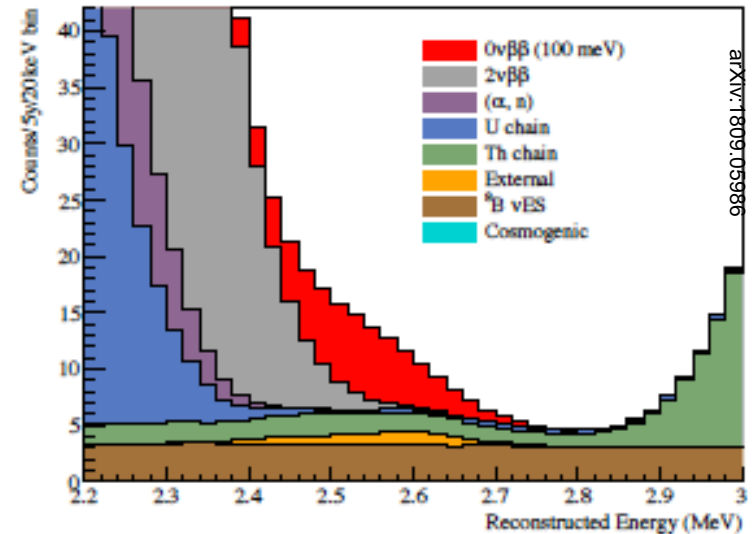
- Shielding and veto solutions are rather robust these days

- $\beta\beta(2\nu)$

- For most present experiments, resolutions are sufficient to prevent tail from intruding on peak

- Becomes a concern as exposures get larger

- Note, resolution, at any experiment scale, is an important issue for signal-to-noise and discovery potential



# As we approach 1 cnt/ton-year, other complications emerge.

## • Long-lived Cosmogenic Isotopes

- Material and experimental design dependent
- Minimize surface exposure for problematic materials
- Development of underground fabrication

## • Anthropomorphic Activities

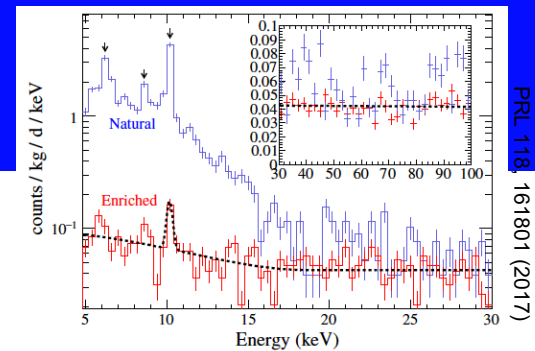
- Frequently related to notable events, precautions usually can be implemented

## • Neutrons (elastic/inelastic reactions, short-lived isotopes)

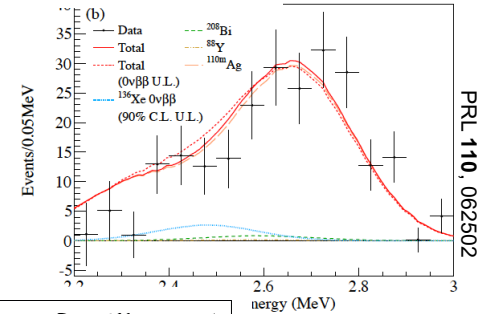
- ( $\alpha, n$ ) and fission  $n$  up to 10 MeV can be shielded
- High-energy- $\mu$  generated  $n$  are a more complicated problem
  - Depth and/or well understood anti-coincidence techniques
  - Rich spectrum, but at low rates it is difficult to discern the actual process, e.g. ( $n, n'\gamma$ ) reactions - which isotope/level
  - Simulation codes still have a lot of uncertainty

## • Neutrinos (elastic or charge-current interactions)

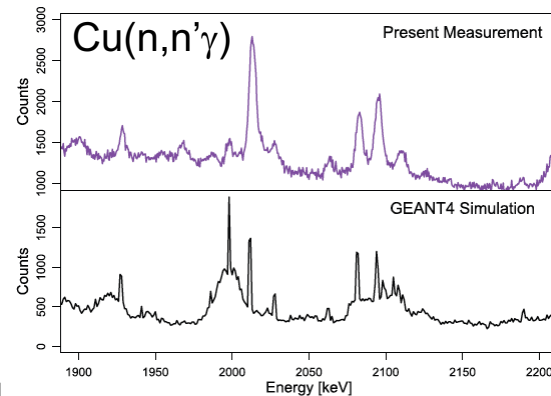
- Must be considered as detectors get big



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